PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 9569WO/UR/MZ	**FOR FURTHER ACTION** See Form PCT/IPEA/416	
International application No. PCT/SE2004/001997	International filing date *(day/month/year)* 22-12-2004	Priority date *(day/month/year)* 31-12-2003
International Patent Classification (IPC) or national classification and IPC See Supplemental Box		
Applicant ABB AB et al		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *(sent to the applicant and to the International Bureau)* a total of 3 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s))
      _____, containing a sequence listing and/or tables related thereto, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).
4. This report contains indications relating to the following items:
   - ☒ Box No. I Basis of the report
   - ☐ Box No. II Priority
   - ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - ☐ Box No. IV Lack of unity of invention
   - ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - ☐ Box No. VI Certain documents cited
   - ☐ Box No. VII Certain defects in the international application
   - ☐ Box No. VIII Certain observations on the international application

Date of submission of the demand	Date of completion of this report
22-06-2005	20-12-2005
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. +46 8 667 72 88	Authorized officer Sture Elnäs /LR Telephone No. +46 8 782 25 00

Form PCT/IPEA/409 (cover sheet) (April 2005)

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of: Cover sheet

INTERNATIONAL PATENT CLASSIFICATION (IPC):

H02H 3/26 (2006.01)
H02H 7/045 (2006.01)

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/SE2004/001997

Box No. I Basis of the report

1. With regard to the **language**, this report is based on:

☒ the international application in the language in which it was filed

☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of:

☐ international search (Rules 12.3(a) and 23.1(b))

☐ publication of the international application (Rule 12.4(a))

☐ international preliminary examination (Rules 55.2(a) and/or 55.3(a))

2. With regard to the **elements** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report):*

☐ the international application as originally filed/furnished

☒ the description:

pages 1-18 as originally filed/furnished

pages* _____ received by this Authority on _____

pages* _____ received by this Authority on _____

☒ the claims:

pages _____ as originally filed/furnished

pages* _____ as amended (together with any statement) under Article 19

pages* 1-3 received by this Authority on 28-10-2005

pages* _____ received by this Authority on _____

☒ the drawings:

pages 2 as originally filed/furnished

pages* _____ received by this Authority on _____

pages* _____ received by this Authority on _____

☐ a sequence listing and/or any related table(s) – see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages _____

☐ the claims, Nos. _____

☐ the drawings, sheets/figs _____

☐ the sequence listing *(specify)*: _____

☐ any table(s) related to the sequence listing *(specify)*: _____

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

☐ the description, pages _____

☐ the claims, Nos. _____

☐ the drawings, sheets/figs _____

☐ the sequence listing *(specify)*: _____

☐ any table(s) related to the sequence listing *(specify)*: _____

* *If item 4 applies, some or all of those sheets may be marked "superseded."*

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/SE2004/001997

Box No. V **Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	1-7	YES
	Claims		NO
Inventive step (IS)	Claims	1-7	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-7	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

Reference is made to the following documents:
D1: US6483680
D2: US5784233

D1 discloses a method for protection of power transformers. The method comprises generation of differential current signals and phasor signals, subsequently analyzing currents in the complex plane. The document discloses differential measurement of the terminal currents (column 1, lines 23-31). The current measured is characterized as the inrush current of the transformer. The inrush may be caused by, for instance, evolving internal faults (column 1, lines 44-67). Consequently, the method proposed by D1 is not solely directed to switching a transformer on, although it is the most severe case, but to the power-through as well.

D2 discloses a numerical differential protection device for a power transformer. All the phase currents of the transformer are measured. A neural network identifies fault conditions.

The problem solved by the invention is detection of low-level internal faults in power transformers, for instance turn-to-turn faults.

D1 is considered being closest in describing the invention.

The invention according to claim 1 differs from D1 by stating calculation of the contributions of the negative sequence currents and comparing relative positions in the complex plane. Comparison in the complex plane is disclosed in D1, but for second harmonic components only. As to the phase angle

.../...

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of: Box V

difference between negative sequence current components, this is not disclosed in D1 in the same manner as is stated in claim 1.

The subject-matter of claim 1 is therefore novel (Article 33(2) PCT) and is considered to involve an inventive step (Article 33(3) PCT).

Claims 2-7 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

The invention is industrially applicable.

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Claims

1. Method for fault detection in a power transformer/-autotransformer and/or interconnected power lines that are within a zone protected by a differential protection, the method being particularly suitable for detecting turn-to-turn faults in power transformer/autotransformer windings and including measuring all individual instantaneous phase currents of the protected object and calculating individual phase currents as fundamental frequency phasors,
the method comprising,
- calculating the contributions of the individual protected object sides negative sequence currents to the total negative sequence differential current by compensating for the phase shift of the power transformer within the protected zone,
- comparing the relative positions of the compensated individual sides negative sequence currents in the complex plane, in order to determine whether the source of the negative sequence currents, i.e. the fault position, is within the protected zone or outside of the protected zone, delimited with current transformer locations,
- disconnecting the protected object if determined that the source of the negative sequence currents is within the protected zone.

2. Device for detecting a fault in a power transformer, autotransformer or interconnected power lines, that are within a zone protected by a differential protection, and particularly suitable for detecting turn-to-turn faults in power transformer/autotransformer windings, comprising means for measuring all individual instantaneous phase

currents of the protected object, and means for calculating individual phase currents as fundamental frequency phasors, **characterized by,**

- means for calculating the contributions of the individual protected object sides negative sequence currents to the total negative sequence differential current by compensating for the phase shift of an eventual power transformer within the protected zone,
- means for comparing the relative positions of the compensated individual sides negative sequence currents in the complex plane, in order to determine whether the source of the negative sequence currents, i.e. the fault position, is within the protected zone or outside of the protected zone, delimited with current transformer locations,
- means for disconnecting the protected object if determined that the source of the negative sequence currents is within the protected zone.

3. Device according to claim 2,
characterized by that,
a fault discriminator is included, that is arranged to determine when a fault occurs.

4. Device according to claim 2 or 3,
characterized by that,
a fault discriminator is included, that is arranged to determine if the fault is internal or external.

5. A computer program comprising computer program code means for carrying out the steps of a method according to claim 1.

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6. A computer readable medium comprising at least part of a computer program according to claim 4.

7. A computer program, according to claim 4, that is, at least partially, provided through a network, such as e.g. internet.